THE LENS

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CHAPTER CONTENTS

INTRODUCTION

The lens of the human eye is a transparent, avascular structure situated between the vitreous humour and the iris. It makes up around one third of the total dioptric power of the eye (approximately 16D) and also fulfils the important role of *accommodation*. Largely isolated from the rest of the body, it is biconvex in shape, measures 10mm in diameter and is 4mm thick when unaccommodated. It has poles, an axis and an equator (Figure 5.1).

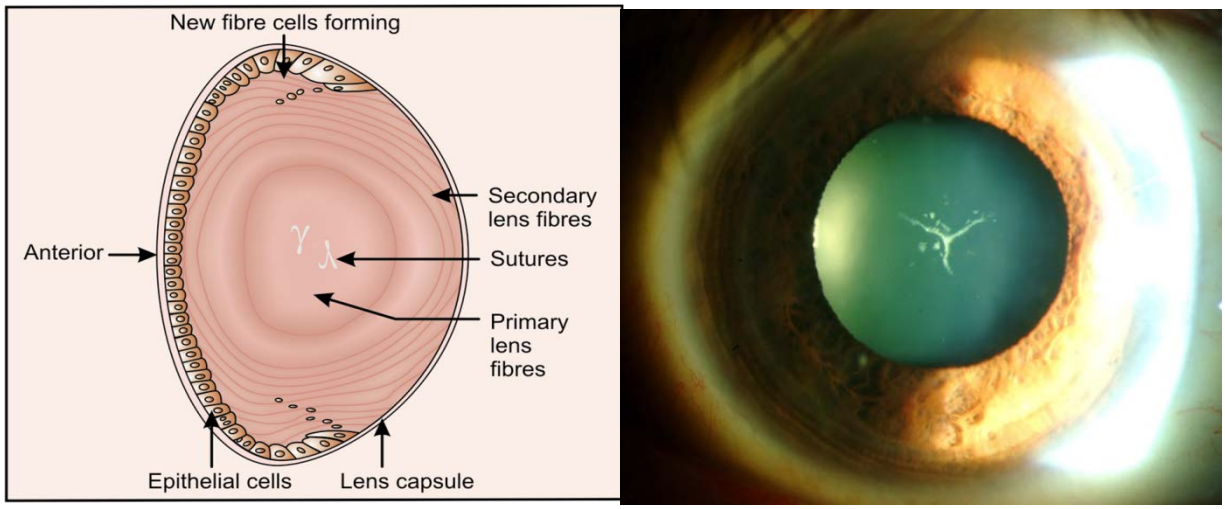

***Figure 5.1**: Schematic overview of the lens (B) slit lamp image of a sutural cataract. Image from http://webeye.ophth.uiowa.edu/eyeforum/atlas/pages/y-suture-cataract.htm*

Refractive index varies across the lens (in the young eye nucleus 1.40; poles 1.385; equator 1.375), but changes with age.

- Anteriorly: in contact with the aqueous which is rapidly replenished
- Posteriorly: in contact with the vitreous which is relatively static

It is connected to the *pars plicata* of the *ciliary body* by suspensory ligaments called *zonules*. (See Uveal Tract, chapter 4, for mechanisms of accommodation).

STRUCTURE AND GROWTH

The lens in enclosed in an outer *capsule*, a collagen glycoprotein elastic basement membrane, which acts as a 'wrapper' but allows passage of sugars, amino acids and lactate. The capsule is thickest just anterior to the equator and thinnest at the posterior pole.

The lens proper, contained inside the capsule, is composed of lamellae (layers) much like an onion. Derived embryologically from *surface ectoderm*, the lens continues to grow throughout life, with the oldest (embryonic and foetal) cells lying deeper in the *nuclear* region. Cells from the lens *epithelium* on the anterior surface (Figure 5.2) are cuboidal in shape and migrate towards the equator where mitotic activity is highest.

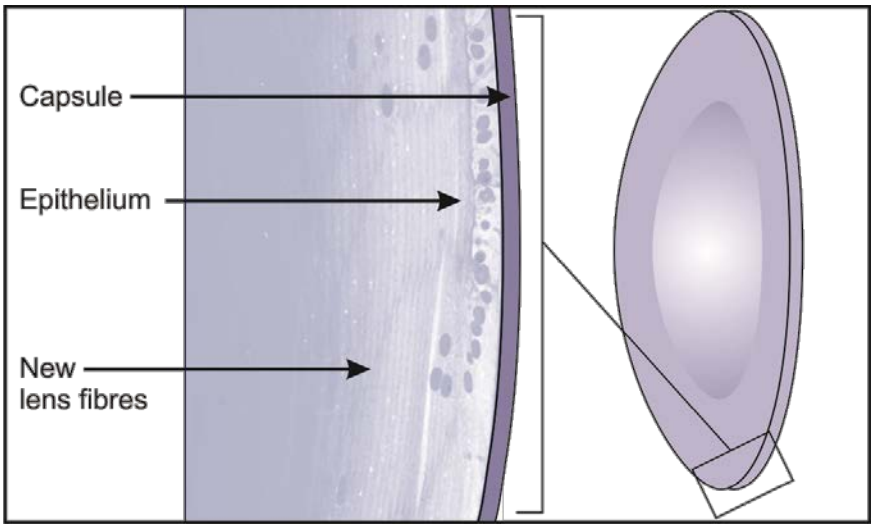

Figure 5.2: *Anterior epithelial cells near equator; Note nuclei migrating inwards before disintegrating*

Cells elongate at the equator to become columnar and form the lens fibres clearly seen in the *cortex* (Figure 5.3).

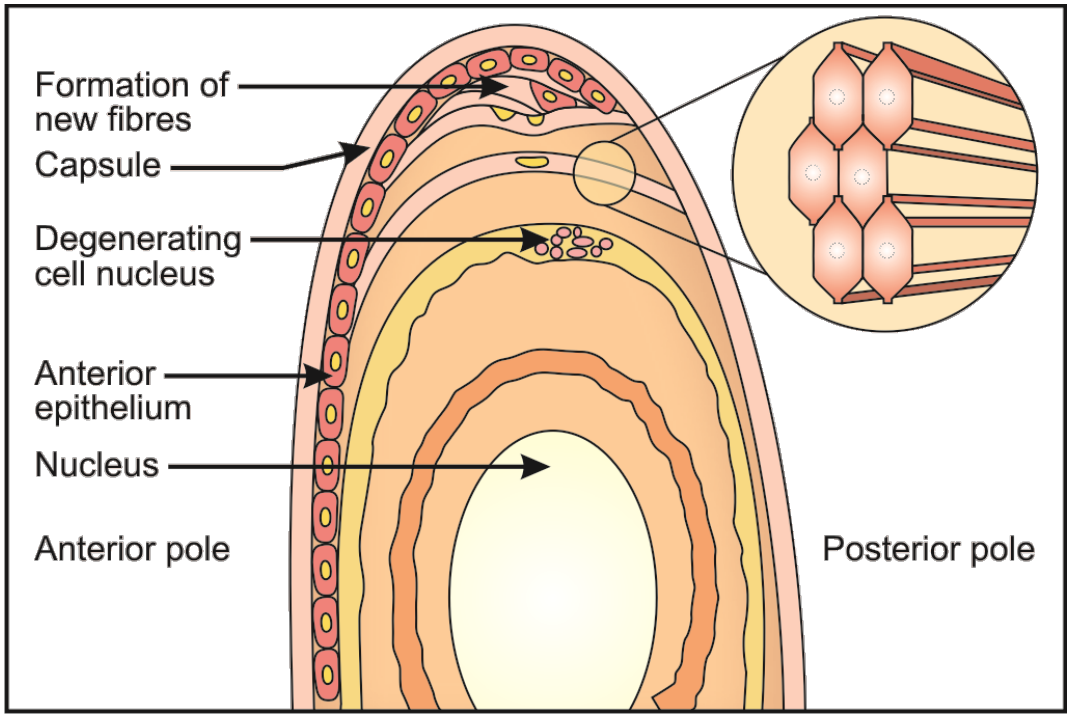

Figure 3: *Formation of lens fibres*

The fibres turn meridionally and elongate along the posterior and then the anterior surface. Lens fibres are 4-7 microns in diameter and packed tightly in a regular hexagonal arrangement. Fibres meet at poles to form the *Y-sutures* (Figure 5.4), a clever packing system that helps to reduce the crowding of fibres at the poles. The posterior Y-suture is inverted with respect to the anterior one. As the lens grows beyond the very early developmental stage, the sutural figure undergoes several bifurcations, making its appearance more radiating and complex as the lens grows ever larger.

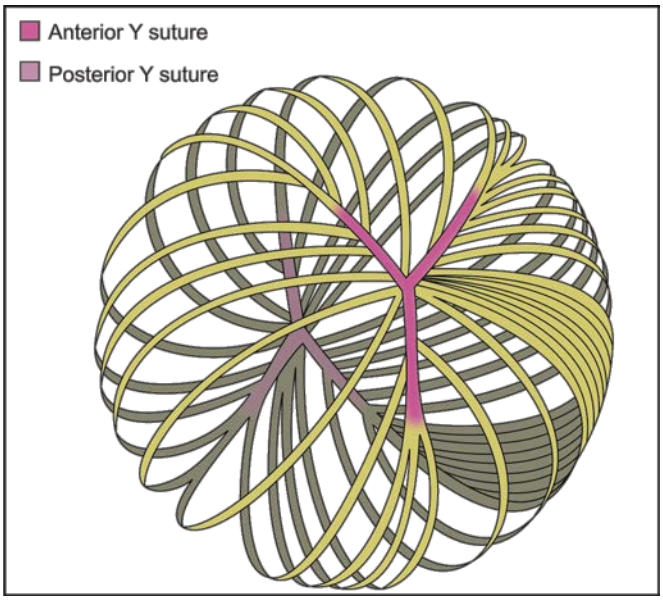

Figure 5.4: *Y sutures caused by fibers meeting at the poles*

As fibres are laid down in layers, the nuclei are seen to migrate inwards and anteriorly from the equator to form a visible *lens bow* after which they disintegrate and disappear.

Fibres are continually formed throughout life but at a slower rate. The lens becomes more compacted with age, especially in the nucleus.

More than 90% of the protein content of the lens is of the water-soluble *crystallin* type. Mostly of the α, β, or γ variety, the crystallins increase the refractive index of the lens while maintaining its transparency.

METABOLISM

To maintain transparency, the lens is avascular. It thus derives its nutrients by anterior diffusion across the capsule to the epithelium from the aqueous humour.

AGE CHANGES

1. Capsule Thickening

The capsule is normally thickest around the poles but increases in overall thickness with age, particularly anteriorly. This is often accompanied by some increased irregularity and loss of transparency, particularly after cataract surgery.

2. Lens sclerosis

The lens increases in density with age, becoming harder at the same time and in part contributing to *presbyopia*, the age-related progressive loss of ability for the lens to reconfigure for near vision. This is also often accompanied by an increase in refractive index, particularly in the nucleus, leading to a myopic refractive shift.

3. Yellowing

The lens nucleus begins to appear yellow from about 35-40 years onwards and this darkening increases further with age. The spectral transmission characteristics of the eye thus change with age displaying an increased absorption of shorter wavelengths.

4. Cataract

Denaturation or disruption of the lens proteins causes a loss of the regular fibre structure of the lens and thus a loss of transparency. Factors increasing the risk of cataract formation include exposure to radiation (particularly short-wavelength), trauma, or the secondary effects of systemic disease such as diabetes or hypertension.

Cataracts are classified by the *location* of the opacity in the lens, e.g. posterior subcapsular, nuclear, etc (Figure 5.5).

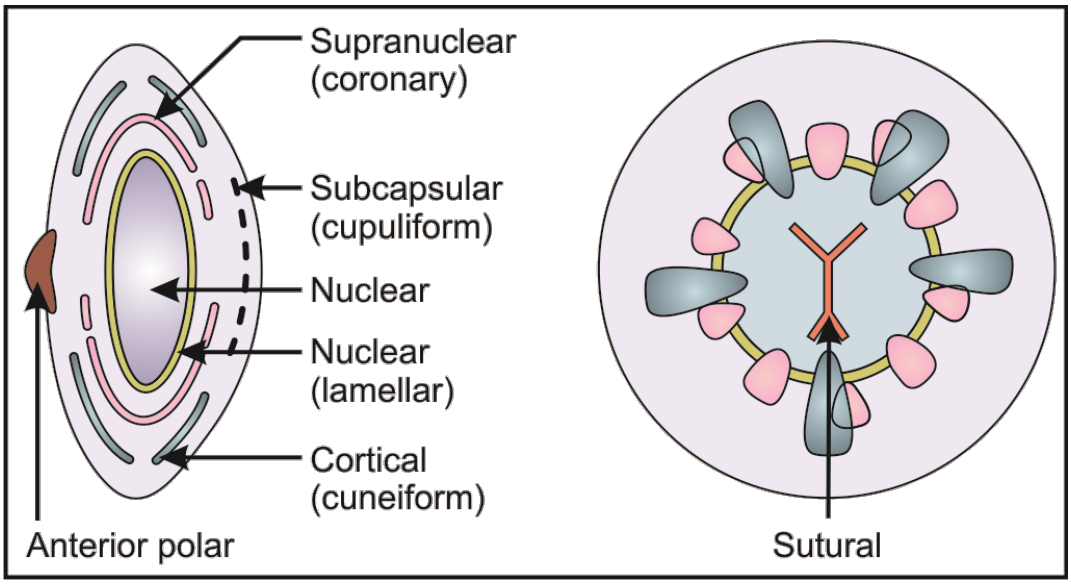

Figure 5.5: *Cataract types; classified by location*